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TEA RESEARCH INSTITUTE

OF CEYLON.

Edited by

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THE TEA RESEARCH INSTITUTE,

St. Coombs, Talawakelle.

H. W. CAVE & CO., COLOMBO.

The Tea Research Institute of Ceylon.

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NOTE.

The Laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Telegraphic Address :—Research, Talawakelle ; Telephone, Talawakelle 44 (Private Exchange). It is particularly requested that letters should not be addressed to officers by name.

FERTILISER RATIONING FOR TEA IN 1947

The allocation of nitrogen for Ceylon in the export year July, 1946-June, 1947 is 85 per cent. of the amount asked for. It will therefore be necessary to maintain rationing at least till the middle of 1947.

With the stocks in hand it is expected that present quotas (50 per cent. above the original figure) will be maintained and permits will be issued accordingly.

The mixture will give the same quantities of nitrogen and phosphoric acid as that now being used but will contain more potash. It will be designated T.330 and will have the following composition :—

	lb.	Nitrogen.	Phosphoric acid.	Potash
Sulphate of ammonia ...	220	45.32	—	—
Mineral phosphate ...	85	—	25.07	—
Muriate of potash ...	25	—	—	15.0
	330	45.32	25.07	15.0

We are advised that shipments will be irregular during the months immediately ahead and it is therefore likely that deliveries in the second quarter will be delayed.

Enquiries about delivery or orders should be addressed to the Fertiliser Control Bureau (P. O. Box 123, Colombo). Only correspondence about quotas should be sent to the Organiser, Fertiliser Rationing (St. Coombs, Talawakelle).

T. EDEN,
Organiser, Fertiliser Rationing.

FREEZING OF TEA LEAF

In certain of the Institute's publications, *e.g.*, Bulletin No. 23 (1941), p. 73 ; Bulletin No. 25 (1943), p. 57 ; and Bulletin No. 26 (1944), pp. 21 and 59, reference was made to preliminary experiments made at St. Coombs in which freezing methods were employed, as an alternative to rolling, in order to break up the leaf.

Our attention has now been called to a patent (Ceylon Patent No. 3134 of 1938) held by Messrs. J. Lyons & Co., Ltd., and covering the use of freezing methods in tea manufacture.

In view of the very preliminary nature of the St. Coombs experiments, it is unlikely that any of our readers in Ceylon have taken any steps in this process. It is necessary, however, to point out that any one thinking of using such freezing methods in tea manufacture should satisfy themselves that they are in no way infringing the patent in question.

SHOT-HOLE BORER REGULATIONS

The regulations made under the Plant Protection Ordinance and published in Gazette No. 7, 911 of March 11, 1932 have been rescinded (Ceylon Government Gazette No. 9, 588 of August 2, 1946).

The regulations now rescinded read :—

1. No tea plants or parts of tea plants (other than tea seed or leaf for manufacture) may be removed or received by any person from any plantation or garden without a permit in writing from the Director of Agriculture, except in the case of plants required for the purpose of scientific investigation in the laboratories of the Department of Agriculture or of the Tea Research Institute of Ceylon.

2. All tea plants or parts of tea plants (other than tea seed or leaf for manufacture) transported or caused to be transported or offered or received for transportation beyond the limit of the plantation or garden of origin must be packed and the package or packages plainly marked with the nature of the contents, the name and address of the sender, and the name of the plantation or garden of origin.

3. No permits will be granted for the removal of any tea stumps or plants from any infested area to or through any area which is not infested, and no person in an area which is not infested shall receive any tea plants or parts of tea plants from an infested area.

4. Any person who commits a breach of any of the above regulations shall be guilty of an offence.

The removal of these restrictions to the free movement of tea plants will not increase the risk of spread of the Shot-hole Borer pest, as was explained on page 48 of this volume of the *Tea Quarterly*.

TEA MANUFACTURE*

J. LAMB

I am going to make this address short and to confine myself to broad principles rather than to details. To deal with details of any of our main lines of research would take a very long time and would also usurp the function of our journal the *Tea Quarterly*. Furthermore, I am sure that the most important thing about this personal contact is to afford an opportunity for the asking of questions. To stimulate questions, I think the best thing to do is to give a general account of our work, but in doing this I want to preserve a sense of perspective. It must be difficult for you to see our work in its true perspective when you are only able to form impressions from reports, probably read at long intervals, and perhaps from an occasional rocket let off by the press, about some particular aspect of our work.

With this end in view I shall divide my report into three sections. The first will deal with pure scientific research which is too technical for publication in

* An address given on July 14th, 1946 to the Ceylon Association in London.

the *Tea Quarterly* and is published in scientific journals. This work makes a contribution to science as a whole and I shall make only a brief mention of it so that my account shall be balanced. The second section will deal with applied science; that is science applied to present methods of manufacture with the object of improving existing methods and machines. The third section will deal with what may loosely be termed invention and deals with long term projects which may not bear fruits for some years to come.

Firstly, then, our activities in pure scientific research. Our principal contribution has been the discovery that the enzyme concerned in tea fermentation is a copper protein compound. We have also been able to indicate something of the mechanism by which the constituents of green leaf are converted into the coloured aromatic compounds which we drink. This work has been of some general scientific interest and the *Biochemical Journal* has accepted seven lengthy papers on this subject.

We also interest ourselves in all analytical methods pertaining to tea, and keep a routine check on conformity to the Food and Drug regulations of the principal consuming countries. Some years ago we had to undertake a lengthy investigation of lead contamination. We also make it our business to keep informed on the biochemical aspects of human nutrition and on the consideration of tea from this angle. Tea contains valuable stimulants, vitamins and elements essential to modern diet. The occurrence of fluorine, which has recently been found to play a vital role in the prevention of dental decay is of special interest to us at the present moment. I have brought all our analytical figures on the occurrence of this element in Ceylon tea with me to London for discussion with Mr. Huxley. I believe that much could be done by closer co-operation between the research and propaganda organisations attached to the tea industry.

I now propose to deal with the second section and our attempt to improve existing methods. On this matter I have the most to say, because it concerns the greater part of our work. I will take the various stages of manufacture in their proper order :—

Firstly, therefore, I will deal with withering. Our chief object has really been to dispense with the process in its present form. Withering is responsible for an entirely disproportionate part of our building and working costs, and is directly responsible for our factory fire problem. We now know that withering is little more than a means for making rolling possible and that it has little inherent virtue. Freezing and thawing will, under certain conditions, render leaf flaccid and capable of taking a twist without going through the ordinary withering process. We are in touch with a British firm of refrigeration engineers and hope to get suitable machinery for semi-commercial scale tests. It is feared, however, that treatment of this nature will prove too expensive, and there is very little practical scope for methods which increase our cost of production. At the moment it is not possible to be certain what the cost of this particular type of treatment would be, and we must carry out further tests before the point can be settled. We have also investigated techniques employed in the dehydration of vegetables with the hope of simplifying and speeding up the withering process. The basic difficulty is to kill the leaf and to destroy its resistance to withering without destroying the enzymes responsible for fermentation. Whilst the leaf is still living, it has a high natural resistance to loss of fluid, but once dead it dries more like wet cloth, and

a comparatively small amount of dry air will wither it down to the requisite degree, in a short space of time. We have found a method for doing this, but unfortunately it requires a high degree of technical control, and is not suitable for operation by our present labour.

In all our research we have to take into account the fact that we have little or no technically skilled labour available in tea factories and that many possible approaches are barred by this obstacle. I shall deal with more radical solutions to the withering problem in the last section of my address.

The next operation, namely rolling, is the one on which we are doing most work and is the principal subject of my address. I have repeatedly emphasised in our publications that present rolling methods are little more, in effect, than the original hand rolling process carried out with a certain amount of mechanical aid. Development of more economical methods is severely limited by the necessity for maintaining a traditional appearance of product, and is a handicap from which most other industries have escaped.

The basic object of rolling is to express the sap or juices from the cells of tea leaf, and to enable the enzymes or ferments to obtain oxygen from the air so that they are able to oxidise the substances which then give rise to the pleasant colour, flavour, and aroma, which are associated with a cup of of tea. Present methods of rolling achieve this object by wringing the juices from the leaf with a twisting action. Little more than 50 to 60 per cent. of the juice is actually extracted and fermented. The rest of the juice stays in the cells and is thrown away with the spent leaf, unless the tea is stewed for long periods in the teapot, and even then, being unfermented, it gives an unpleasant bitter taste to the liquor. There is therefore plenty of room for improvement in rolling methods, but we must bear in mind that the trade at present insists on the traditional black, twisted appearance of the final product, and still views with suspicion any change of grading percentages. Our grades have not for many years past, borne any relation to the fine or coarse parts of the flush. The only approximately true grades are orange pekoe or rather nowadays, broken pekoe, which is made by cutting what would have become mainly orange pekoe. This grade consists almost entirely of stalk. Any part of the bud and two leaves may appear in any other grade. Grading percentages are therefore no more than mere mechanical sizes and I have recently been very surprised to find how much misunderstanding there is on this point.

Shortly after I first joined the Institute we commenced a long and detailed study of the mechanism of rolling and the functions of the many various types of battens employed on roller tables. It really was surprising how little was known about the reasons for all the complicated shapes and sizes, but the explanation has proved to be a simple one. Only those portions of battens which cover the centre of the table, that is to say, the parts usually fixed on the door, have any real effect. In other words the greater part of the old types of batten are virtually useless. Much more effective rolling action may be obtained by accentuating the fittings on the door and removing the battens from the table iteself. Devices based on this principle are being introduced by engineering firms in Ceylon and although they appear simple in shape, their dimensions are very critical and their method of construction and fitting of the highest importance. The optimum dimensions vary with the size and type of roller. Much trial and error experimentation is necessary before they can be made available

for all sizes and types of rollers, and we are of the opinion that conversions should be left entirely to reputable engineering firms rather than to estate carpenters. Errors in dimensions and construction may prove disastrous, and we strongly recommend that estates should not be in too much a hurry to convert rollers.

Another interesting result of this investigation has been the unmasking of the pressure cap as an imposter. Far from helping the rolling process it impedes the vital action which, as I have mentioned, is the twisting or wringing action. The wringing action of the circular tea roller is entirely dependent on the circulation of leaf. As the leaf turns over and over in the jacket, the drag between the units (that is to say, the pieces of flush comprising two leaves and a bud) twists up the leaf and imparts the wringing action. In other words the leaf rolls itself, once set into motion and kept churning over. As soon as dhool separates, the wringing action is finished because the dhool particles are too small to grip each other with any force. In fact dhool separation is the result of the units adjusting themselves in such a way as to offer the least resistance to the motion of the roller. I have always suspected the pressure cap, because it obviously arrests circulation of leaf, and therefore must impede the twisting process.

When the cap is screwed down tightly it induces another type of dhool formation. The leaf compressed in the jacket by the pressure cap is dragged round and round over the battens and torn to pieces by sheer abrasive action. Thus dhool may be torn off from leaf which is not properly twisted and poor liquoring qualities will result from this type of action. In practice we have of course adopted a compromise and have raised and lowered the cap at frequent intervals as well as varying the degree of pressure applied. The so-called light pressure rolling will allow a certain amount of circulation to take place in the jacket provided the centre battens are reasonably efficient. In the newer, so-called cone-rolling method the projection or boss attached to the centre of the table, stirs the leaf like a gigantic spoon and intensifies circulation and the resultant twisting action. Also in addition to the twisting action, the leaf caught between the projection and the jacket is given a hard nip which greatly assists the extraction of juice and the formation of dhool, but here again if the gap between the projection and the jacket be too small the leaf is smashed rather than twisted into dhool. The most critical feature in the design of this type of roller is the dimension of this gap between the projection and the jacket in relation to the diameter of the jacket and the crank throw. If the dimensions are wrong, leaf will be smashed and torn and severe damage may be done to the roller, and that is why we strongly recommend that conversions should be carried out by engineers with experience of the method.

It is most important to realise that once leaf is reduced in size, the wringing action is much more difficult to apply. Dhool of a sort could be produced by a cutting action alone, but only the cells along the cuts would be ruptured. To apply the twisting action to the rest of the cells in the small strips of cut tissue becomes infinitely more difficult than it is in entire pieces of flush. For this reason it is undoubtedly best to take small first dhool percentages so that the whole flush is thoroughly wrung out before it is reduced to dhool. Even with the new types of fitting it is best to concentrate on twisting in one type of roller and to use another type of roller for reduction to dhool. This, in practice means a large gap between jacket and projection for first rolls, and a smaller gap for later rolls. Once leaf is well twisted it can be reduced

to any desirable size very quickly, and this size should logically be governed by the size of leaf required by the various markets rather than by any conventional or traditional percentages of so-called grades.

By employing these newer methods three twenty-minute rolls may do all and more than four thirty-minute rolls on the older types of table : that is to say sixty minutes' rolling time, in place of one hundred and twenty minutes' rolling time. This pratically doubles the output per roller and per cooly. In addition, owing to the ease of charging into an open top jacket and the elimination of the necessity for constant pressure cap manipulation, labour is further reduced. Throw-out of leaf is also done away with because the plain table allows the jacket to be lowered to within a very small clearance of the table. I should like to point out that two engineering firms have done a great deal of work in Ceylon on this type of rolling and that we are not claiming any exclusive credit for its development. It has been our happy privilege to work in close touch with most of the engineers in Ceylon and freely acknowledge that we have gained as much as we have given by co-operation.

In 1938 whilst we were in the earlier stages of unravelling the complications of ordinary rolling, we were fortunate in coming into contact with Mr. Clive Meares who brought a new type of rolling machine to Ceylon. After seeing some of his earlier results we were unable to ignore the fact that the machine was capable of producing teas of outstanding liquoring quality, although the appearance of the teas made by this method was at this stage very poor. We suggested that further experiments should be carried out at St. Coombs and Mr. Meares worked with us for over a month, in which time we together succeeded in making teas of orthodox appearance without any serious diminution of the fine liquoring quality. Experiments passed on to a fully commercial scale of working and we sold invoices of these teas on the London market. We carried out normal and Clivemeare manufacture on alternative days during both monsoon and dry weather periods and in both cases the Clivemeare roller produced teas which actually sold at a penny to threepence better than the normal teas. When I came home at the end of 1938 I was able to discuss these invoices with blenders, and they were quite definite about their usefulness and quality. Only a few weeks ago, one of the principal London blenders commented on the good quality of these invoices which he had remembered from 1938.

If it had not been for our contract with the M.O.F. which precluded the alteration of our grading percentages we should have continued Clivemeare manufacture at St. Coombs. The process increases the percentages of fannings and dust at the expense of leafy pekoes. The B.O.P. percentage is unchanged.

I have previously referred to misunderstanding about grade percentages and have been astonished during recent visits to blenders, by the amount of cutting and even grinding which is applied to teas before blending. The production of small teas in tea factories themselves has, of course, increased enormously during the past decade, but it appears to me that we shall be asked for much more smaller tea in the future and I must say that it is much better for everyone concerned to carry out this reduction in the rolling room rather than to cut and grind dry leaf. The Clivemeare roller therefore fits in with a current trend and we recommend it for earnest consideration, along with cone rolling.

Having given some indication of the practical promise of these particular experiments, I want to explain how the underlying theory of this method of rolling has influenced our lines of thought.

I have said that the expression of juice and exposure of juice to air and constant enzymic activity is the basic requirement of rolling. I have also explained how the circular tea roller depends upon a twisting or wringing action to achieve this purpose. Now I want to put it to you that there must be quicker and more efficient ways of getting juice out of the leaf than by twisting or wringing and I am quite certain that there are.

The Clivemeare roller is a precision machine consisting essentially of two stainless steel cylindrical rollers like a rubber roller or domestic mangle. In Clivemeare manufacture the gap between these rollers is adjusted to 10/1000th. inch and withered leaf is passed through this gap to give it an intense nip and disrupt as many cells as possible without breaking the leaf up entirely. After this, a single roll in an ordinary roller is enough to complete the rolling process, and impart an orthodox appearance to the finished product. The method is therefore simple and economical as well as effective. Here I must leave rolling although I shall follow up the same line of thought in the final section.

The next stage in normal manufacture is fermentation, and with regard to this stage I may say that our laboratory investigations have shewn that fermentation is made or marred by rolling, and all that can be done after rolling is to provide an ample supply of humid air.

With regard to drying, I have only to say that all the results of a long and intensive series of experiments on tea drying were published sometime ago. We have specified the best drying conditions for Ceylon manufacture and have taken into account all factors, including keeping quality which I think is really the most important. We have no cause to change our recommendations and believe that the present method of drying tea is efficient and that it will remain unchanged for a considerable time. We are considering modern high frequency electrical methods but fear that they will anyway prove too expensive to apply to tea drying.

I now come to the final section in which I intend to deal with the more inventive side of our work which is concerned with future requirements and prospects. Our costs of production in Ceylon have already risen to alarming heights and it is difficult to be optimistic about long term prospects. I am sure that much will depend on our ability to reduce or even maintain levels in view of rising labour costs and generally difficult labour conditions. We have to face up to problems which have confronted many or most other industries during some period of their history and much will depend on our adaptability in the fairly near future.

Such operations as withering will have to be modified or eliminated. Withering takes practically half the present factory labour and also necessitates our large inflammable factories. Acreage per factory is limited because of transport problems raised by the care required in the handling of leaf which has to undergo a withering process. A fire in a large factory also causes more serious disorganisation than a fire in a small one, apart from the fact that capital loss is greater. Rolling is another tiresome process at present involving much handling which could only be eliminated by the most complicated conveyor systems and being a batch process is altogether uneconomical compared to continuous or line processes employed by most modern industries.

I have already inferred, when dealing with our rolling experiments, that rolling in a circular type roller is only necessary because of the traditional appearance of the twisted leaf, and that withering is only necessary because of the fact that the wringing action can only be applied to withered leaf. Fresh leaf merely breaks up into fragments when rolled in an ordinary roller. If we can make a good liquoring product by cheaper and simpler means why should we remain for ever bound to a particular style of product? Flour, sugar, houses, motor cars, clothes all change their appearances during the course of the years and there is no reason why the appearance of tea should not change. The majority of tea consumers are certainly not enraptured by the beauties of black, well twisted leaf but are undoubtedly shrewed judges of a pungent, aromatic liquor which has a pleasant bright red colour after milk is added. Such changes cannot take place overnight, but even now the appearance of the leaf is slowly changing and all popular brands are at least much smaller in size than they were even a few years ago.

Instead of wringing juice out of cells on to the surface of leaf, where it can ferment, leaf can be instantly reduced to a mass of broken cells and this mass can be aerated so as to produce a complete fermentation, of almost all the contained juice, instead of a fraction of it as at present. We have done this by passing green leaf through the Clivemeare roller with the rollers touching, that is through a gap of less than 1/1000th inch as against the 10/1000th in use for Clivemeare manufacture. At first, after drying the mass, we compressed it into cakes which could be broken down, blended and re-compressed into tablets. In these particular experiments we did not aerate the leaf sufficiently during fermentation and a slightly bitter character resulted in the liquors. As you know, the idea of tablets was not received at all well, although the matter was distorted by the most unfortunate publicity which we regretted even more than you did.

Our most recent experiments have been devoted to complete aeration during fermentation, and to the production of imitation B.O.P. fannings and dust. We can produce dry leaf which is passable in colour and appearance within two hours of the arrival of the green leaf at the factory by what is still an extremely simple process, although not quite so simple as the first process. I have recently taken samples to Messrs. Brooke Bond, English and Scottish C.W.S., Liptons, and Lyons and all have agreed that the liquoring qualities are good, and I think I could justifiably say exceptionally good, especially when the teas are milked. The difference between normal teas and new process teas made from the same batch of well-bulked leaf is really very remarkable when milk is added. I have also been assured that we have not lost any Ceylon character or flavour. One blender told me that they are accentuated and that one chest of this tea would give as much Ceylon character and flavour to a blend as two or three chests of normal tea.

This all sounds very promising, which I think it is, but of course, there is a catch in it, and that is the leaf is lacking in weight. A ¼ lb. of this leaf will not go into a standard ¼ lb. packet. Blenders are not, at least at the moment, prepared to entertain the idea of increasing the size of their packets and would find great difficulty in using the leaf. However, when I return to Ceylon I shall try to overcome what we hope will be the last obstacle, and I hope that when I next come home on leave perhaps I shall be able to report considerable progress along these lines.

DISCUSSION

In reply to an enquiry from Mr. W. Coombe as to the reason why ¼-lb. of the

new process teas would not go into a standard ¼-lb. packet, Mr. Lamb said that they were too light and flaky, but supplementary methods are now being employed to increase the density. It was possible already to produce a shotty form of pekoe of which 120 lb. could be packed in a full chest, the minimum quantity required by blenders being 110 lb. He assured Mr. Coombe that not a single drop of juice was lost in the new process of rolling unwithered leaf.

Mr. Horner expressed the hope that, in all their experiments and research, the Institute would keep before them the consideration that standardised methods of manufacture might be disastrous to Ceylon. Many estates depended upon their own particular methods of manufacture for their market and had everything to lose by the present craze for large-scale planning and bulk buying. Those in London were no less receptive to new ideas than planters in Ceylon, but the Institute, which had deservedly acquired considerable prestige during the first 20 years of its existence, should continue to be the servant rather than the leader of the Industry and should attempt nothing which would tend to destroy the individuality of each estate and its superintendent : the Ceylon tea producing industry was vitally dependent upon the special characteristics of its teas.

Mr. Lamb said that, as a result of sending samples to different parts of the world, the Institute was fully alive to these factors. At present they were rightly endeavouring to find out what the requirements of blenders were and the first obstacle to be overcome was that of filling the ¼-lb. packet. Dealers' teas would continue to be manufactured by the old method : general standardisation was not an objective. It was a fact, however, that the special characteristics of individual estates still came through the new method of manufacture, and it was still possible for a taster to pick out teas made from old and young leaf and to detect seasonal variations. Any inherent quality was fully maintained.

Mr. A. A. Prideaux referred to an address given by Dr. Carpenter some years previously, in which it had been stated that withering was as much a chemical as a mechanical process but that less was known about the former aspect, and enquired whether the Tea Research Institute ignored the chemical side.

Mr. Lamb said that, so far as Ceylon conditions were concerned, there was no chemical change that a chemist could detect, apart from certain slight changes due to bacteria.

Lt.-Col. Agar enquired whether the new methods had only been tried in the St. Coombs Factory.

Mr. Lamb replied that the Institute had tried to meet this difficulty by bringing low-country teas to St. Coombs for manufacture there with the minimum possible delay in transit. Low-country teas, however, did not benefit so much from the new process as those from up-country estates because the quality was not there. It was hoped to establish a separate Research Station in the low-country in the near future but considerable expense would be involved.

In reply to Mr. George Brown, who enquired whether experiments on dehydration such as had been applied to vegetables had been carried out by the Institute, Mr. Lamb said that the difficulty had been to kill the leaf in such a way that it withered quickly and this had been overcome by a high temperature blast of 10 or 20 seconds' duration. In dehydration the objective was to kill everything, including the

enzymes and to avoid the change of colour that was necessary in the case of tea.

In reply to an enquiry from Mr. Cooke, Mr. Lamb said that there had been very little Legge Cutter manufacture in Ceylon and that he knew very little about this process. Mr. Napier Ford had recently shewn him some quite black normal looking teas but he imagined that similar difficulties with density occurred with this process.

Mr. Snelling, referring to the shotty pekoe which Mr. Lamb had mentioned, asked whether this was black or red in colour, and whether the liquor was similar to that of B.O.P. Mr. Lamb replied that the liquor was similar and that the colour of the leaf, though not entirely black, was blacker than many North Indian teas or teas from Uva and Maturata and not sufficiently red for any housewife to detect. These teas only contained a small percentage of dust.

Mr. Coombe suggested that the higher the specific gravity of the leaf the better so far as quality and keeping properties were concerned and that possibly some quality was lost in the new process, as a flaky tea would not keep so well as one with a greater density.

Mr. Lamb agreed that efficiency of manufacture could be assessed by the weight of the resultant teas, but this test was not applicable to teas manufactured by the new process. The loss of weight was purely a physical matter and, as in the case of paper cut into large or small strips, the amount which could be packed in a chest depended upon the size of the particles. The object of rolling the leaf smaller was to increase the density and to satisfy the trade demands.

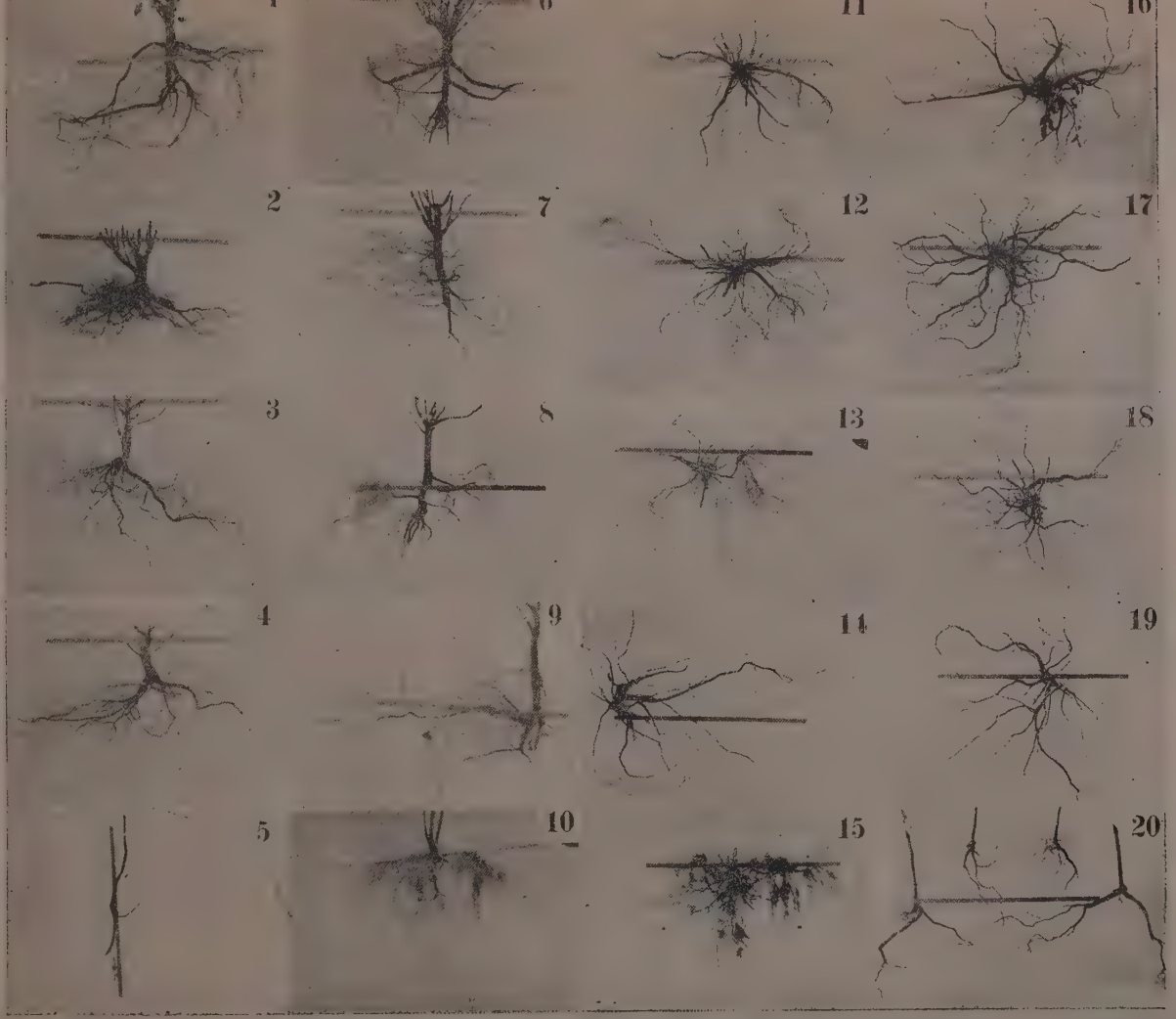
The President concluded the discussion with a cordial expression of thanks to Mr. Lamb for his interesting lecture and for the replies which he had so readily given to the enquiries addressed to him.

TAPROOTS AND LATERAL ROOTS

F. R. TUBBS

The conceptions of the taproot of the tea bush as an organ essential to the proper security of the bush within the soil, and as playing an important or essential part in the provision of water during periods of drought is still dying very hard in planting circles. While, no doubt, the taproot is of value to the plant if it exists, it is too often forgotten that by no means every bush has a taproot, and those that have none shew no visible difference from their neighbours. Take, for instance, a bush grown from a two-year-old stump as compared with a bush grown from seed-at-stake. In the latter case, if the attack of cutworm or white grub has not served it, a taproot may be present. In the former, no taproot, but only laterals grown from the seedling taproot are present. This, however, does not appear to be generally realised.

It is true that one or more of the laterals produced from the stump of the taproot of a two-year-old seedling may grow straight downwards and simulate a genuine taproot. But such is also true of lateral roots grown from any part of the root stock, and in considering drought resistance it is necessary to consider the depth to which any part of the root system reaches, rather than the



Figs. 1—15 & 16—20, Plants derived from Cuttings; Figs. 1 & 16, Clone 4 (6 years old); 2 & 17, Clone 26 (8 years old); 3 & 18 Clone 331 (5 years old); 4 & 19, Clone 510 (4 years old); 5) Clone 603 (4 years in nursery); 20, Clone 26 (4 years in nursery).

Figs. 6 -15, Plants grown from two-year-old seedling stumps, after 8 years in the field.
(Figs. 6 & 11, 7 & 12, etc. are of the same plants.)

presence, absence, or depth of the taproot as such.

It is well known that the finer rootlets of a tree may extend far beyond the permanent and thicker portions of the root, but any bulk of rootlets leads to the production of a relatively robust branch of the root system leading to them. It was therefore decided to uproot carefully a number of tea bushes grown from cuttings with a view to determining their general habit of rooting, in view of the fact that the common belief in the all-round efficacy of a taproot had led to fears that vegetatively propagated bushes would not stand up to field conditions as well as seedling plants.

Photographs were then taken of the root systems in two planes at right angles, showing distribution both in depth and in area (Figs. 1-20). The rod shown in each photograph is one metre (39 inches) long. The writer is much indebted to Mr. C. A. Loos, who carried out the whole of the photographic work involved.

Figures 1-4 are illustrative of the type of root system produced on bushes from single node cuttings. It will be observed that they all shew a tendency to develop a spreading root system within the fertile upper layer of soil, but that roots descend, although not vertically, as low as the vertical roots descending from the seedling root stocks shewn in the photographs numbered 6-10. This accounts for the fact that clones have stood up to drought conditions as well as ordinary tea, both in Uva and in Dimbula.

Further examination of the seedling root systems shewn in Figs. 6-10 indicates that although some of the lateral roots produced from the original two-year-old stump grow vertically downward, the bulk of the root system is concentrated in the upper layers of soil. Not only this, but certain of the lateral roots may, as in the clonal plants, descend as deeply as the taproot or its substitute. It is also interesting to observe that, while photographs 6 and 7 will doubtless delight the heart of the confirmed taproot enthusiast, they cannot by any means be called typical — a fact that has been confirmed over many years of examination of mature root systems from many parts of the Island.

Figures 6-10 exhibit a complete range of form from the type with a central root stock and thickened laterals to forms such as those shewn in Figures 9 and 10, which might well be thought indistinguishable from the clonal series 1-4. To complete the picture, reference may be made to Figures 5 and 20 which illustrate the roots of plants grown from cuttings and left four years in the nursery. Fig. 5 is admittedly exceptional, the common types being shewn in Fig. 20. Figs. 11-15 show the same root systems as Figs. 6-10, photographed to show their spread, for comparison with the similar clonal root systems shewn in photographs 16-19. It is noteworthy that in all cases except one the specimens grown from cuttings are several years younger than the seedling roots, all of which had been grown on in the field for 8 years, after being grown for two years in the nursery as stumps.

It is not likely that the taproot is a useless organ — in times of drought it may be of value — but the point which should not be missed is that it is not essential, and its function can be, and often is, taken over by lateral roots with no loss of efficiency.

One may, perhaps, conclude with the observation that provided the selection and testing of clones is carried out under the local conditions of an estate, a discussion about root systems is besides the point. If a clone is found to yield a larger quantity of better tea than the average bush on the estate, *under local conditions of drought, etc.*, from a commercial point of view it would appear to be an idle curiosity that demands to know whether the bush has a taproot or, indeed, any roots at all.

NOTES ON THE EFFECT OF *DRYMARIA* ON AN ESTATE IN UVA*

T. GLEN DICKSON

HISTORY

Drymaria cordata appeared first in the experimental weeding plots late in 1936. These experimental plots were laid down in 1932 to observe the effects of a weed cover on tea. Grasses only were removed from them and tall weeds were slashed across monthly, the whole area being forked in both rows twice a year. Any form of creeping weed that would cover the soil was encouraged and *Drymaria* was considered to be an acquisition.

By April 1937, *Drymaria* had established itself and was spreading all over the experimental weeding plots. In November 1938, *Drymaria,* in conjunction with *Oxalis,* had formed a complete cover in these plots, and it was decided to eliminate all other forms of weeds in future. This was done and the plots were cleaned up and brought into the normal weeding round by March 1939 when all special cultivation, like extra forking, was abolished.

In the meanwhile *Drymaria* had been spreading into the surrounding fields, and by December 1941 the soil of all the central fields was covered by a dense growth. The weeding policy at this date was to treat *Drymaria* as a cover crop and to leave it unmolested in the cultivation lines, making the weeders clean it from round the bushes in the tea lines monthly.

At the end of 1942, the soil in all except the comparatively isolated fields at the extreme ends of the group was more or less completely covered with *Drymaria,* and it was beginning to creep into even the isolated fields. The whole estate had an unbroken cover of *Drymaria* on it in 1943, which proved to be the peak year of its growth.

Since then the *Drymaria* has been gradually losing its vitality and has been declining steadily, not only in the rapidity and exuberance of its growth but also in the number of new seedlings coming up after each period of drought. It has disappeared, in fact, almost completely from some portions of the fields wherein it appeared first, and quite considerable parts of the estate are comparatively free from it now.

EFFECT ON CROP

Drymaria has seasonal periods of maximum growth correspond with the flushing periods of the tea. It is reasonable to suppose that active competition with the tea for available foodstuffs during maximum flushing periods would result in reduced tea crops. Table 1 shows the March rush crop yield from this estate compared with the average of two other *Drymaria*-free Uva estates in the same Company.

Table 2 shows the seasons' final yields for the estate compared to the mean yields for the same periods of two other of the Company's estates in Uva, which are used as a control. In no case are "Off grades" included in the yields. General cultivation, plucking, and labour conditions were very

* The Institute does not necessarily endorse the views expressed in papers contributed by persons other than members of the staff.

TABLE I

Tea Yields in lb. per acre during the March Rush.

Year	1938	1939	1940	1941	1942	1943	1944	1945	1946
Infested estate	133	135	163	—	78	63	102	87	103
Average of 2 other estates	102	88	131	—	112	82	105	97	107
Difference	+31	+47	+32	—	–34	–19	–3	–10	–4

TABLE II

Tea Yields in lb. per acre and the amounts of nitrogen applied (in lb. per acre.)

Season	1937/38	1938/39	1939/40	1940/41	1941/42	1942/43	1943/44	1944/45
	Yields							
Infested estate	800	863	908	*	745	670	699	812
Average of 2 other estates	758	823	842		823	829	766	824
Difference	+42	+40	+66	*	–78	–159	–67	–12
	Nitrogen applied							
Infested estate	35·2	35·2	42·36	42·38	25·1	25·5	16·27	26·0
Average of 2 other estates	35·2	35·2	35·2	35·2	25·0	26·84	17·08	25·0

* Crop restricted.

similar on all 3 estates throughout the period under review and full crops were harvested without restriction of any kind.

For the three seasons before *Drymaria* may have begun to influence crop, this estate had averaged 49.3 lb. per acre of crop *more* than the control estates. During the four seasons after *Drymaria* had become established, crop averaged 79 lb. per acre *less* than the control estates. It is difficult to escape the conclusion that *Drymaria* has been responsible for an average annual loss of crop, amounting to well over 100 lb. per acre off this estate during the past four seasons.

The weeding experiments carried out on St. Coombs Estate by the Tea Research Institute have shown (Eden 1944) that weeds have caused definite loss of crop during the first 6 years of the experiments, and that it was only after seven years that "equilibrium conditions" were reached with crop levelling out on the non-weeded and the clean weeded plots.

The crop figures given above for this estate compare fairly closely with the St. Coombs experimental weeding figures, (*loc. cit.* p. 42) except for the fact that the loss of crop has been heavier on this estate, due possibly to the cover of *Drymaria* being thicker here than at St. Coombs. The writer would like to think that the recent improvement in crop returns noticeable on this property compared with the control estates, was in some part caused by the efforts in fighting *Drymaria* that are described in these notes; but he must point out that any improvement in crop may just as well have been from the same natural causes that operated at St. Coombs.

CONTROL

When *Drymaria* first appeared, it seemed to be an ideal cover crop as it grew along the ground and gripped the soil securely. It was, however, a prolific grower and shoot after shoot grew out until the ground was covered. Then the trouble started, for as soon as it had no more ground

to grow over, the weed started to grow up on itself and on top of everything it could, including the tea. It liked plenty of sun and moisture and made its most prolific growth in the pruned areas, where the tea prunings formed an ideal trellis work support for it to spread over. Heavy shade or sunless weather limited its growth to a reasonable rate and it was found that a good thick cover of tea in its third or fourth year from pruning, when it was well manured and carried adequate leaf, was an excellent controlling factor.

As it ceased to grow after three weeks of drought and died back after six weeks of drought, its control was easy in the dry weather and during the early part of the monsoon. This was because it is a slow starter after rain. The *Oxalis* sprang up first and formed a thick cover rapidly and it was not until some weeks later that the *Drymaria* commenced to appear and eventually to cover the *Oxalis*.

The two major periods of growth occur in Uva in normal climatic seasons, during November and during March and April. This has an important bearing on the control methods adopted, as very few estates in Uva can spare the 15 coolies an acre necessary to clean weed the whole property monthly during flushing periods without loss of crop.

For the first year or two after establishment, it appeared to possess enormous vitality and quite phenomenal powers of growth. This proved, however, to be a passing phase, the duration of which would seem to depend to a large extent on the degree of richness of the soil in particular fields, as the weed settled down after some years into quite a good cover crop capable of being kept in reasonable control.

During the initial urge of growth it thrived on hard treatment, and clean weeding at 15 coolies an acre produced an even thicker cover of *Drymaria* at the next weeding round. It was decided, therefore, to concentrate on keeping it out of the bushes by scraping it monthly out of the tea lines into the cultivation lines, where it was left undisturbed. This method of control was started in 1938 and continued until 1944, when it became obvious that the continual removal of soil from round the bushes and its deposit into the middle of the cultivation lines, was having unforeseen effects on cultivation.

EFFECTS OF CULTIVATION

This continual scraping round the base of the bushes in the tea rows, tended to remove earth from round the bole and to push it into the cultivation lines which caused the ground level to rise in the cultivation lines and to sink in the tea lines. Moreover, a certain proportion of the *Drymaria* in the cultivation lines was rooted up and killed in the process, and this, together with the prunings and other litter from the tea, shade trees and green manure, collected in the cultivation rows decayed under the thick layer of unmolested *Drymaria*. This layer of *Drymaria* died during each period of drought and further increased the height of the mound running down the cultivation lines.

Since cultivation was done when *Drymaria* was growing strongly, the forker, unless he were exceptionally conscientious and was using a nearly new fork, never penetrated to the true soil that lay beneath the ridge of matted *Drymaria, Drymaria* roots and decayed vegetation. These ridges were about 4 inches high in 3rd and 4th year fields, and in 1st and 2nd year fields sometimes increased to nine inches. The bulk of the tea roots lay beneath this surface mat.

It proved unsatisfactory to spread the artificial manure on top of this heap of *Drymaria,* particularly when insoluble fertilisers were used, as a large part of the manure stuck to the *Drymaria,* which was usually damp at the time of application ; so the forkers could not push it down into the soil. The portion sticking to the *Drymaria* washed off eventually in the next shower of rain, but it had to penetrate the heap of *Drymaria* and *Drymaria* roots along the cultivation lines before it could reach the tea feeding roots below. It is reasonable to assume that the *Drymaria* got the first share and that the tea got only what the *Drymaria* could not absorb. This was considered to be the cause of the decline in yield in 1942 and it was decided that the mound in the cultivation lines must be levelled off before manuring in future.

This was done in 1943 by special coolies equipped with mamoties, who scraped away the mound and levelled off the cultivation rows. The manure was then spread on top of the ground and forked in, along with all *Drymaria* and decaying vegetable matter that the mound contained. The amount of material so collected and buried was astonishing and although the work was expensive and needed about 6 coolies an acre, the *Drymaria* took 2 months to recover from the treatment, and the expenditure was saved on the next 2 weeding rounds. This method of manure application was followed by an immediate comparative improvement in yield. The decline of the previous three seasons had been arrested.

The method, however, required additional labour at inconvenient times and as the *Drymaria* had lost its initial urge by this time and had settled down to a quieter existence, thereby reducing the necessity for such energetic scraping into the cultivation lines monthly, it was decided to dispense with the removal of the *Drymaria* mounds before manuring and to adopt a different method of manure application.

The system decided upon was as follows : Each forker was issued with his own hand sack of manure and each row was envelope-forked. The forker was made to put his own manure into the bottom of each envelope well below ground level and to envelope in the usual manner when forking the next envelope. This system, when properly carried out, got the manure into the ground below the root level of the *Drymaria* and other shallow-rooted weeds.

It proved to be satisfactory in practice and was further modified last season to annual alternate row forking. This appears to be the cheapest and most efficient method of ensuring that the tea gets its fair share of the manure.

EFFECTS ON THE APPEARANCE OF THE TEA

There can be no dispute that the tea in clean weeded areas looks healthier and shows up darker green in colour than the tea in surrounding areas with a cover of *Drymaria* on them. The tea in the *Drymaria* areas has the yellow appearance of Nuwara Eliya tea in February.

This property, situated at 4,500 feet elevation, gets the N. E. Monsoon more severely than do most estates in Uva, and the tea together with the green manure and *Grevilleas* experience a definite "wintering" period during the N. E. Monsoon. The tea sheds a lot of its leaf during this wintering period in the fields more than 2 years from pruning, unless it has had the stimulus to growth provided by the application of artificial manure about 2 months previously.

Fields carrying a heavy cover of *Drymaria,* particularly if the soil is not good, have tended to winter more severely than clean fields and to take longer to come into full leaf again. The burying of large masses

of *Drymaria,* when manuring, undoubtedly caused a temporary falling off in appearance, although the tea made a quick enough recovery afterwards.

EFFECT OF WEEDING COSTS

Drymaria did not produce any immediate or appreciable rise in weeding cost, when it first came in, and when control was effected by scraping it into the cultivation lines only ; for the cover that it produced hid all the small creeping weeds and grasses, which remained undetected and showed up only when the *Drymaria* died back in dry weather.

Young weed seedlings germinated in reduced number under the *Drymaria* cover and were not easily seen by the weeders. These seedlings might have been as much as several inches high and would have been removed under a normal system of clean weeding. They tended to be overlooked under the cover of *Drymaria* and to seed before the next weeding round was due. These two factors, plus a certain laxness in weeding, difficult to combat, and engendered by the dirty appearance of the estate when covered by *Drymaria,* tended to raise weeding costs gradually from year to year.

This rise in weeding cost has been a substantial one. For years before *Drymaria* became established on this property, the whole estate had been weeded on the contract system with the rate based on an allowance of just over 3 coolies an acre ; but with the spread of *Drymaria,* more and more contractors have found that this allowance is insufficient.

Gang weeding the division on which *Drymaria* first appeared took an average of 10.7 coolies an acre a round last season. Even when allowance is made for the reduced tasks now prevailing, compared with pre-war days, for the more expensive nature of gang weeding, compared with contract weeding, and for the fact that monthly rounds were not always kept up the substantial nature of the rise in costs is apparent.

ERADICATION

In 1943 it was decided to attempt to clean weed certain fields in order to observe the effects of clean weeding on appearance and yield.

The cleaning up started in July and the average monthly labour taken for clean weeding is given in Table 3.

TABLE III

Average Number of Labourers required for weeding per acre per round.

1943/44	(12 months)	15·04
1944/45	(12 ,,)	8·00
1945/46	(10 ,,)	6·49

The soil in the poorer parts of these fields is free of *Drymaria* seed now, but it is subject to constant re-infection from surrounding areas, which have not been cleaned up. The soil in the good hollows still contains *Drymaria* seed, which germinates whenever the ground is disturbed by forking or after prolonged spells of wet weather, but the cost of weeding is falling steadily and indications are that it will have returned to normal in another 2 seasons' time.

When the costs are compared with the figure of 10.7 coolies an acre given previously for gang weeding the ordinary fields during season 1944-45 by drawing the *Drymaria* into the cultivation lines, there is every indication that the policy of clean weeding will prove to be the cheaper policy. provided always that the labour to keep up regular monthly rounds is available.

Drymaria seeds very rapidly and regular monthly weeding rounds are essential for success. As weeding these fields took

as many as 24½ coolies an acre in some months during the first season of clean weeding, it is important to start in a small way and not to try to clean up a larger area than can be completed monthly.

During 1944, when it became apparent that *Drymaria* could be weeded out, once its initial vitality had spent itself, it was decided to treat it as a weed and to get it out of all the fields wherein its growth was diminishing, whenever labour permitted. This was done from 1945 onwards and is the present policy with regard to *Drymaria*.

It was realised that labour would not be available at all times of the year to keep up monthly weeding rounds under this policy, and that we could never hope to eradicate it completely that way, when the soil is often infected with fresh seed between weeding rounds. As rounds have seldom gone longer than 2 months, however, it has the advantage that at least half the estate is reasonably free of *Drymaria* at any given time. I believe, too, that this decision is hastening the natural decline of the *Drymaria* in the old areas and that in the course of time it will have no more nuisance value than any other weed, and there will be a consequent fall in weeding costs.

EFFECT ON EROSION

Erosion occurs to a marked extent during 3 periods of the year in Uva. The first period is the dry season during the July-September drought, when dry erosion causes considerable loss of top soil on all steep fields. The second period occurs in October, when the heavy inter-monsoon thunderstorms that break the drought can do a lot of damage. The third period occurs in March and April, when the inter-monsoon thunderstorms again are capable of a lot of damage.

Drymaria is valuable for stopping wash in the March-April period and very little occurs in fields carrying a good cover of *Drymaria*. *Drymaria* also makes new soil very rapidly by holding up all leaf-fall, small prunings and other refuse that would otherwise be washed away by rain or blown into the drain by wind, or helped down the hill by gravity and coolies' feet. This new soil is black in colour and full of humus and must help the soil considerably to withstand the erosive effects of wind and rain during the other two periods of the year when drought has killed off the *Drymaria* cover.

EFFECT ON DISEASE

The litter that accumulates under *Drymaria* may form an ideal medium for the spread of the fungus *Rosellinia* and all known disease patches should be clean weeded.

EFFECT ON DRAINING

Drymaria is very fond of drains and ravines and grow profusely in them. At the end of April, it was quite common to see the field drains full to the top with the weed. The run-off from rain percolated through this, which acted as a filter and trapped most of the soil, fallen leaf and other particles usually carried off by flood water. This was all to the good and certainly the work of cleaning silt-pits in the clean weeded fields was far more expensive than in the fields with *Drymaria*, in spite of the growth of weed in the drains.

Drymaria growing in the ravines holds up a lot of silt too, causing the soil level to rise constantly and necessitating periodical deepening operations.

SUMMARY

It is impossible to deny that *Drymaria* is expensive. There is little doubt that it causes initial loss of crop and that from the short term point of view, it should be prevented from establishing itself on an estate at all cost.

It is not possible to say yet whether the new soil that it makes and the loss of top soil that it prevents will restore fertility sufficiently in the course of a long term of years to result in an eventual gain of crop. This is still a matter for conjecture and those in charge of estate policy must decide for themselves whether such a problematical gain in crop at some future date is worth the price that must be paid in the meanwhile.

These notes are produced in the hope that they will be of use to those who will be faced with this problem at some future date, should *Drymaria* continue to spread at its present rapid rate through the tea plantations of Uva.

REFERENCE

Eden, T. (1944). Report of the Agricultural Chemist for 1943 —. *T.R.I Bull.* 25, pp. 38-45

BLISTER BLIGHT

F. R. TUBBS

"Blister Blight" disease of tea has been known in North India for nearly ninety years, but apart from two severe outbreaks in the first decade of this century, does not appear to have become economically serious. The import of tea seeds into Ceylon was prohibited mainly to prevent the entry of this disease, and it remained unknown in South India and Ceylon until 1946. In October, specimens were received from Dolosbage, and in the ensuing fortnight isolated reports were received from six other districts on the western face of the central range of hills. Thereafter, reports have multiplied until it is now (18th December) known on 68 such estates at elevations between, 5,000 to 1,500 feet. It has not so far been reported from Uva. Its frequency is highest in tipping fields and decreases with the age of the field from pruning.

The disease is most easily recognised during the later stages of infection. It is almost entirely confined to the younger leaves, occasionally spreading to the young stem causing the shoot to dieback. Infections of the leaves are local, and do not result in the death of the leaf. The first visible sign of its presence on a leaf is the formation of a slightly yellowish translucent area, which later becomes shiny and depressed on the upper surface. This produces a swelling or 'blister' on the lower surface of the leaf, from ⅛ in. to ½ in. or more across, which becomes white a few days later. In sunny weather these blisters rapidly become brown and dry up, but in wet weather they remain white for some days. The cause of the disease is a species of *Exobasidium*, probably *E. vexans*.

The future course of the disease in Ceylon is unpredictable. It is undoubtedly capable, as is the case with many other diseases, of causing serious damage if conditions for its epidemic multiplication occur over a long period, or recur at frequent intervals. Fortunately, in North India at least, the fungus has proved extremely susceptible to changes in climatic conditions, which in nature occur sufficiently frequently to prevent the disease causing serious damage.

Managers are requested to keep the Institute advised of the occurrence of this disease on their estates, the extent of the damage, and of the weather conditions during the attack.

TEA SELECTION

III—THE VEGETATIVE PROPAGATION OF SELECTED BUSHES

The early investigations into the vegetative propagation of tea at St. Coombs covered most of the known methods of propagating plants by vegetative means, during the course of which much useful experience was gained. It is not proposed to go into detail concerning the various methods used, since only the use of small cuttings fulfils all the requirements necessary to render vegetative propagation of tea an economic proposition under Ceylon's conditions.

These requirements may be summarised as follows :—

(i) Only small portions of plant material must be necessary, to permit of large numbers of progeny being obtained from a single mother bush.

(ii) Young portions of the parent plant must be suitable, in order that successive crops of material suitable for propagation may be obtained in a short time.

(iii) The method must not involve the growth of the selected scion upon a seedling stock in the case of plants intended for commercial plucking, to obviate the problem of stock growth.

(iv) To be of more than restricted use to the industry, the method must be capable of adaptation to routine estate conditions.

The use of small cuttings, each bearing a single leaf, derived from young shoots of the mother bush would obviously satisfy the first three conditions. It has, in addition, been shown during the war that provided the use of the method is restricted to suitable clones *i.e.*, those which will form roots relatively easily, there is no reason why the method should not be used under estate conditions. As emphasised in an earlier article, the method being dependent on the rooting of cuttings, the clones which are found to be poor rooters must be discarded as part of the preliminary selection, however desirable their other characteristics may be. There is no point in wasting time, space, and money on a "shy-rooter" where the object is to obtain rapid and cheap multiplication of the stock by means of cuttings. The point has been again stressed, because while the principles of selection for yield and, later, quality are easily grasped, the need for selecting sufficient mother bushes to allow of the rigorous discarding of shy-rooters is frequently overlooked.

The preceding article on this subject dealt with methods of selection of mother bushes and with the simplifications it has been found possible to introduce as the result of experience. The subsequent treatment of the selected bushes should be related to the nursery programme and, in order to explain this, it is necessary to anticipate a little and state that the best time for placing cuttings in the nursery is at the commencement of the main rainy season, whether it be the South-West or North-East Monsoon. If ample time exists between the selection of the mother bush and the anticipated date of planting the nursery beds, the mother bushes should be pruned back and allowed to grow unchecked until the red bark at the base of

the rested "tipping shoots" is beginning to split and consequently to develop small greyish streaks. The period of time required for this to occur under local conditions will be known approximately. It will be found to vary considerably with elevation and to lie between two and six months after tipping would normally have been carried out. The type of shoot obtained in this way bears large leaves with long internodes and provides particularly easy material to work with. When time is shorter, the bush may be rested as it stands, the existing flush being allowed to run up and their vigorous growth encouraged by thinning out unnecessary lateral shoots within the bush. This will shorten the time considerably but, if the time available is very short, cuttings may even be taken from the lateral branches of the bearing bush. The latter material is not particularly suitable, being often over-ripe, and having very short internodes, with the result that cuttings have little depth in the nursery bed.

The preparation of the nursery involves nothing elaborate. If the soil is poor, the incorporation of *large* bulks of leafy material, which may be thoroughly mixed with tea fluff, if available, to hasten its rapid and even breakdown, should be carried out in ample time. The amount of material added should be generous, for it is essentially a horticultural operation which is being embarked upon. It should be incorporated well down and thoroughly mixed with the soil. To achieve this, mamoty work is preferable to forking. The soil should be again worked over prior to planting to ensure thorough mixing, but it is bad practice to manure the beds with tea fluff or cattle bulk just before planting the cuttings. The nursery should be well drained, but with water nearby, as for any other tea nursery. The beds should not be high, it being better to deepen the paths later if necessary rather than to plant cuttings upon a bed whose surface is raised six inches or more, the edges of which suffer in dry weather from lateral drying out and in wet weather from wash. No special drainage layer below the bed is necessary under normal conditions, but here local knowledge must be the guide. It is apparent from the above that there is nothing abnormal required in the preparation of the nursery, but three points may be emphasised in passing :—

(i) It is as necessary to avoid alkaline areas of soil as it is in the case of tea seed nurseries ;

(ii) Cuttings will not succeed in open nursery beds if planted in "hungry" or gravelly soil, with a low moisture-retaining capacity. The roots of a cutting are for some-time concentrated in the upper three inches of soil and such conditions would allow of no margin of safety to cover the inevitable accidents of weather or occasionally inefficient watering, against which the seedling is better protected than the young cutting.

(iii) Direct drip on to the beds from overhanging shade must be avoided.

Assuming, then, that the type of propagation bed has been prepared which we would expect to see used for the purpose in our own garden (and by this is expected no more than *should* normally be achieved for ordinary seed nurseries if the best results are to be obtained) planting up can be proceeded with. Points requiring detailed consideration in any large scale work are : transport of the clonal material to the nursery, the making of cuttings, planting, shading, watering, labelling, weeding, and manuring.

It is not necessary to make the cuttings in the field at the site of the mother bush. Shoots sufficient to produce the required number of cuttings are better severed from the mother bush, placed in a bucket containing a couple of inches of water, and carried therein to the nursery. On wet, drizzling days transport may be made in baskets. In order to avoid muddles, it is best to ensure that leaf from only one mother bush at a time arrives at the nursery. The selection of those portions of the shoots suitable for cuttings is achieved by discarding, as work proceeds, the soft sappy tips and hardened bases of the shoots and also, if material is ample, those portions of the shoots having short internodes and crowded leaves. The cuttings as made should be allowed to fall into a flat bowl or dish of water, from which they are taken for planting in the bed. A satisfactory method of handling the shoots is as follows : Take a shoot, and with a *really* sharp thin bladed pen knife, or budding knife, cut off the soft flexible tip of the shoot. Then, holding the shoot close to and below the second leaf from the top, which should be pointing towards the body, cut the stem immediately above the second leaf and its subtended bud with a lateral motion of the knife. (A cut made directly towards the body is liable to slash the second leaf). The process is then repeated, turning each second leaf from the top towards the body, until the whole shoot has been cut up, or until an area of the stem is reached on which fissuring of the reddened outer tissues has begun.

The cuttings, taken as required from the water, are inserted just clear of one another in rows across the bed, the stems being "firmed" into the soil with the fingers at such an angle that the leaf lies along and close to the surface of the soil. A cooly working at the side inserts fern as each row is completed, the ferning being fairly dense. As each batch is completed a sprinkling of water may be given to dampen the fern and settle the cuttings. It is scarcely necessary to say that overcast days after or during rainy weather should be chosen for the work.

A frequent enquiry is whether pandals are preferable to ferning. Fern is preferred for two reasons — firstly, a pandal must be very wide, if not inconveniently low, to prevent morning and afternoon sun reaching the cuttings and, secondly, the fern preserves a still atmosphere around the cuttings which is easily kept moist. Watering depends upon circumstances but the general principle is to keep the fern moistened by light sprinkles for the first ten days or so and thereafter to rely upon soakings every three or four days as necessary rather than upon daily general watering which may be insufficient to do more than wet the top half inch of soil. If fairly dense, the ferning breaks up the water applied from the rose of a can sufficiently to prevent any trouble arising from puddling of the upper layer of soil.

Labelling of the cuttings, as of the mother bushes, is of great importance and again a plan of the bed is of great value in repairing the mischief that podians and others cause upon occasion. It is desirable to leave at least one foot between the cuttings of each clone and to insert previously prepared permanent labels as each batch is completed. The stick or post should be sufficiently durable to last at least one year.

Weeding must be carried out through the fern, the latter being thickened up again as work proceeds. It is not safe to expose shaded cuttings to even a few minutes of bright sunlight by removing the shade completely, scorch being caused by such treatment. In practice, no real difficulty arises from this. Between four and six months after planting, when the majority of the cuttings have developed bunches of rootlets, shading may be very gradually

thinned during cloudy or rainy weather, by ceasing to thicken up after weeding or to replace the natural wastage of the fern. About this time, good soakings with manure water, prepared by soaking sacks of cow-dung in a barrel of water, will have a good effect. It is useless putting the plants out in the field during or before adverse weather, and if the weather during the second six months of their growth in the nursery is dry, every effort by watering and manuring should be made to keep them growing so that well-grown young plants of up to a foot or more in height are available at the end of the period. If they are left in the nursery for a year, having been planted at the beginning of a wet season, suitable weather for establishment when put out in the field is likely.

In the first beds of cuttings from mother bushes selected for further examination marked differences in the stand of rooted plants will be found. If the average stand in the first trial amounts to, say, sixty per cent of the original cuttings, clones giving less than thirty to forty per cent may be discarded. The only case in which further trial of an apparently poor rooter is worth while is where there is obvious reason for failure, *e.g.*, one bed as a whole has done badly due to poaching by shade tree roots, poor soil, etc. In such a case, the worst rooters in that bed only should be discarded.

In general, it has been found at St. Coombs that good rooters in the nursery establish well in the field, but it is very desirable to ensure that sufficient cuttings of each clone are available for supplying the multiplication plots later in the season. It is usually possible to make a very good guess as to which will prove the best clones from the uniformity of stand, spread and vigour of the young plants in the multiplication plots after a year or so's growth. There is no reason at all why material from the mother bushes of such clones should not be propagated for use as supplies pending further test, for the numbers available in the early stages will be relatively small, and whatever their quality, it is unlikely on the average to be worse than the average of seedlings, and their ease of establishment and subsequent yield is likely to be greater. In other words, the progeny of such bushes will be better on the average than the seedlings that would otherwise be used.

POSTSCRIPT

Recent experience has suggested that one cause of poor rooting in the nurseries is damage to the base of the stem inflicted during planting. If the labourer works in the most convenient position, he squats on the bed facing his work with the result that the soil becomes much consolidated before the cuttings are inserted. If cuttings are thrust into such soil, the soft outer tissues are forced away from the central stem and injured, the end of the cutting presenting a frayed appearance. The remedy is for the soil in front of the labourer to be loosened with a handfork before the cuttings are inserted. Thereafter, the soil is firmed immediately around the stem by a heavy pressure of the fingers as already described. This procedure can be quickly carried out, and imposes little delay in planting.

MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 21-6-46

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon, held at the Ceylon Tea Propaganda Board Offices, Colombo, on Friday, 21st June, 1946, at 2-30 p.m.

Present.—The Chairman, Planters' Association of Ceylon (Mr. R. Singleton-Salmon) the Acting Chairman; the Acting Financial Secretary (Mr. C. E. Jones); the Director of Agriculture (Mr. L. J. de S. Seneviratne, C.C.S.); Messrs. H. S. Hurst, H. de T. Wilkinson Kay, J C. Kelly, D. T. Richards, W. H. Attfield, F. Amarasuriya and Dr. R. V. Norris (Director and Secretary).

Apologies for absence were received from Messrs. E. E. Spencer (Chairman, C.E.P.A.) and Mr. E. G. Groves. The Chairman informed the Board that Mr. R C. Kannangara, M.S.C., was unfortunately still ill and unable to attend.

(1) The Notice convening the Meeting was read.

(2) The Minutes of the Meeting of the Board held on the 17th April were confirmed, subject to two minor alterations already issued to members, and signed.

3. MEMBERSHIP OF THE BOARD

The following changes in the personnel of the Board were reported :—

(a) Mr. H. de T. Wilkinson Kay had been nominated by the P.A. of Ceylon with effect from the 17th May *vice* Mr. R. Gorton Coombe resigned.

(b) Mr. E. G. Groves has been nominated by the P.A. of Ceylon to act for Mr. R. C. Scott, C.B.E., during the latter's absence on leave.

The Chairman welcomed Mr. Wilkinson Kay and Mr. W. H. Attfield whose nomination to the Board had been reported at the last meeting.

4. FINANCE

(a) Accounts of the Institute for 1945 and the Auditors' Reports thereon.—The Accounts had been issued to members and the Chairman said that these, with the Auditors' Reports thereon, had been considered by the Finance Committee. The Chairman summarised the accounts as follows :—

Receipts.—The most notable items was the reduction, amounting to Rs. 60,992, in the proceeds from the cess as compared with the previous year. This represented a reduction in tea exports of approximately 43½ million pounds, due chiefly, of course, to the severe drought experienced in the early months of the year, and to shipments in November and December being held up by the harbour strike.

It was satisfactory that, in spite of the adverse climatic conditions, the profit on estate account at Rs. 46,015 was only Rs. 145 below that for 1944. With miscellaneous receipts at Rs. 10,604, the total receipts amounted to Rs 381,748, a reduction of Rs: 60,579 on the previous year.

Expenditure.—Research Revenue Expenditure at Rs. 315,486 was up by

Rs. 22,507 on the previous year. The 1945 expenditure, however, included a non-recurring item of Rs. 34,750, being the cost of making up the Board's contribution to the Senior, Junior and Sub. Staff Provident Funds to the 10 per cent basis. The item was to an appreciable extent offset by savings in senior staff salaries, due to the resignation of Mr. King, and final adjustments in the sums paid in making up the pay of officers on military service.

Including interest payment on the Government loan (Rs. 28,159) and Depreciation (Rs. 30,150) total expenditure on Revenue amounted to Rs. 373,795 or Rs. 12,345 above the 1944 figure.

The surplus on Revenue account was, therefore, Rs. 7,953 as against Rs. 80,627 in 1944, the fall being, as already explained, chiefly due to the reduction in the proceeds from the cess.

Capital expenditure amounted to Rs. 61,454, comprising Rs. 46,517 in repayment of the Government Loan and Rs. 14,937 spent on assets.

After allowing for all other liabilities, the Depreciation Reserve, amounting to Rs. 572,931 at the 31st December, was covered to the extent of 90 per cent by cash, investments and liquid assets of Rs. 521,224.

The Chairman said the Auditors' Reports were of the usual satisfactory nature and the Finance Committee unanimously recommended the adoption of the Accounts. He moved from the Chair that this be done.—Carried.

(b) T. R. I. Junior Staff Provident Fund.

The Chairman said the audited accounts of the Junior Staff Provident Fund also revealed a satisfactory state of affairs. The contributions account as at 31st December stood at Rs. 109,568 and there was an excess of income over expenditure in 1945 of Rs. 702. It was satisfactory to note the extent to which this fund has been used for insurance purposes. Endowment policies to the face value of some Rs. 80,000 (exclusive of bonuses) had been taken up through the fund. Of the amount of Rs. 17,789, shown on current account at 31.12.45, a further sum of Rs. 15,000 had since been invested in Ceylon 2½ per cent National Development Loan 1955-60.

The accounts were approved.

(c) T. R. I. Junior Staff Medical Fund.

The Chairman pointed out that Rs. 1,675 had been paid out in medical expenses during the year which indicated the great assistance the fund was to the Junior Staff. There was an excess of income over expenditure of Rs. 191 on the year's working.

The accounts were approved.

(d) T. R. I. Accounts to 30th April, 1946.

The Chairman referred to the high balance on current account which was due to the maturing of a fixed deposit and recent heavy receipts from tea sales. He reported that a further sum of Rs. 30,000 had since been invested in Ceylon 3 per cent National Development Loan 1965-70. The balance was still high but expenditure in the near future would be heavy as work was now proceeding on the Sprinkler installation. He suggested the Board might give discretion to himself and the Director to make a further investment shortly. This was agreed to.

In regard to the estate working account, the Chairman pointed out that the debit balance was merely due to the lag in receiving payment for tea already manufactured. A sum of approximately Rs. 50,000 was due on this account. Taking in this figure there would actually be a substantial balance on the credit side. Crop to 31st

May was 35,340 lb. above the corresponding figure for 1945.

The accounts were adopted.

(e) Additional Votes.

The Board sanctioned the following additional votes :—

(i) Research Capital Expenditure Rs. 3,000 the estimated net cost of replacing the T. R. I. car.

(ii) Estate Capital Expenditure Rs. 7,500, being the figure provisionally estimated for the purchase of a leaf lorry for St. Coombs Estate.

5. ST COOMBS ESTATE

(a) *Acting Superintendent.*—The Chairman reported that in accordance with instructions given at the previous meeting, Mr. R. C. Scott (then Chairman), the Visiting Agent and the Director have been able to secure the services of Mr. F. C. Daniel as Acting Superintendent. Mr. Daniel had been informed that the appointment would be for a period of not less than three months. Mr. Daniel had joined for duty on the 27th May.

As Mr. Rogers would not be able to resume duty, the Chairman suggested the acting appointment be extended to six months while consideration was given to the question of the permanent appointment for which Mr. Daniel would be considered with such other names as might be submitted.

After a short discussion it was unanimously decided that :—

(1) Mr. Daniel's salary be increased to Rs. 1,000 per mensem, and

(2) The Acting appointment be extended to a period of six months.

The Board recorded their thanks to Dr. Eden for the efficient manner in which he had acted as Superintendent of the estate for eight months.

Superintendent, Mr. J. A. Rogers

The Chairman reported that, in accordance with the instructions of the Board, arrangements were made for Mr. Rogers to be examined by a Medical Board. The Board would hear with great regret the Doctors' report that Mr. Rogers would be unable to resume his work as Superintendent at the end of his sick leave on the 30th June.

The Board unanimously recorded their deep appreciation of Mr. Rogers' loyal and conscientious services to the Institute and asked the Director to convey to Mr. Rogers their sympathy with him in the circumstances leading to his retirement.

6. MINUTES OF THE MEETING OF THE ESTATE & EXPERIMENTAL SUB-COMMITTEE HELD ON THE 6TH JUNE, 1946

These had been issued to members. The chief item in the minutes relating to the question of a Low-Country Research Station was dealt with under item 7 below. The Board approved the suggestion of the Sub-Committee that a surveyor be engaged to demarcate the estate into five-acre blocks to facilitate weeding contracts.

7. SUB-STATION FOR RESEARCH IN THE LOW-COUNTRY

Copies of a letter from the Chairman of the Sabaragamuwa Planters' Association forwarding minutes of a meeting of representatives of the low-country districts held at Ratnapura on the 24th March had been issued to members. Copies of a letter dated the 12th June from the Low-Country Products Association, and received on the 18th June, were also tabled. Both the above letters pressed for the early setting up of a Low-country Research Station which, it

was suggested, should be in the Kalutara district.

The Chairman said the matter had been very fully considered by the Estate and Experimental Sub-Committee at its meeting held on the 6th June, the minutes of which were in the hands of members. The Board had agreed in principle that outside work should be undertaken and the difficulty was how to implement this. The Experimental Committee were unanimously of opinion that the programme of work at St. Coombs must first be safeguarded and, in this connection, had recorded their views that the existing Junior Staff were inadequate in number for this purpose. In such circumstances, it was at present quite impossible to detach any of the existing staff for work at an outstation. It would, therefore, be necessary in the first place to increase the cadre at St. Coombs and thereby train the necessary personnel. Subsequently, such men would be available for work elsewhere as considered necessary, their places at St. Coombs being filled by new appointments. He hoped the Board would accept this view and agree that such a proposal was the quickest, and indeed the only, way to meet the wishes of the low-country. At the same time the Chairman reminded the Board that a considerable building programme would be involved.

In reply to the Director of Agriculture, Dr. Norris said that if a definite Sub-Station were set up, a staff of one senior and three junior officers would probably be necessary. He supported the view expressed by the Chairman and stressed that it was useless to send out into the district imperfectly trained men, and that adequate supervision was essestial.

In reply to the Director of Agriculture, who enquired whether the Experimental Committee was agreed in principle that a Sub-Station for Research should be established in the low-country, the Chairman replied that the Board having approved in principle the establishment of Research in the low-country, the Estate and Experimental Sub-Committee could only discuss the way by which the Board's wishes could be implemented.

The Director of Agriculture then enquired whether the Board should not put this principle into practice without delay and what objection there could be to calling for applications for an officer who could eventually be placed in charge of the Sub-Station. The Chairman said there seemed no objection to this and it could be done.

After further discussion it was decided that the problem of outside work should be approached in the above manner. The Board then proceeded to consider the strengthening of the staff at St. Coombs.

Senior Staff.—It was pointed out that steps had already been taken to fill the vacancy created by Dr. Bond's resignation and it was agreed to fill the further vacancy arising from Mr. King's resignation. The Chairman pointed out that Dr. Bond had been appointed during the war and had been able to occupy the bungalow of an officer on war service. With a full staff of seven senior officers, including the Director, they would be one bungalow short. The cost of a senior staff bungalow at the present time would probably be some Rs. 80,000. Any further bungalow would have to be on a different site, and it might be desirable to allocate this to the Director, the existing bungalow being utilised for one of the other officers. The matter had been considered by the Finance Committee and Mr. Kelly had suggested that, temporarily at any rate, the existing six bungalows would prove sufficient as there would usually be one officer on leave. Mr. Kelly enlarged on this proposal, which was supported by Mr. Jones, and the Director was asked to prepare a leave schedule

which would indicate how far such an arrangement would be practical. The Chairman agreed that a temporary solution might be found in this way but thought the long term policy should envisage the full number of bungalows.

Junior Staff.—The Chairman said the first thing to be considered was the appointment of a second assistant in the Mycological Division which was a matter of urgency. Provision had, in fact, been made in the estimates for the salary of this post as from July but, here again, housing was involved. At present there was in this section one assistant only (Mr. Loos) who was in the Research Grade. Mr. Loos was a very highly trained officer and it was considered essential by the Experimental Committee that a junior assistant should be appointed to understudy him, otherwise a very serious gap in the continuity of the work in the Mycological Division would eventually occur. Quarters for this officer would be required, which under present conditions would probably cost about Rs. 20,000 plus say, Rs. 1,500 for furniture and equipment.

Mr. Wilkinson Kay enquired whether a building of a temporary nature could not be erected. The Chairman, who was supported by Mr. Hurst and Mr. Amarasuriya, pointed out that very little saving was likely to be achieved by this.

After a further discussion, it was unanimously agreed to appoint a second assistant in the Mycological Division and to build a bungalow for this officer on the lines of the existing Junior Staff bungalows.

With regard to the other research divisions, the Chairman said there was a vacancy for a Research Assistant in the Agricultural Chemist's department and a further junior assistant was needed by the Plant Physiologist. These appointments, if sanctioned, would involve the construction of two further Junior Staff bungalows and he thought these should be put in hand. The extra staff was urgently required and some saving would be effected by building all three bungalows at the same time.

In reply to Mr. Amarasuriya who suggested a building reserve should be established, the Director pointed out that funds for this purpose were already available.

After a short discussion it was unanimously decided that the appointments suggested should be made and the necessary housing provided.

A Building Committee consisting of the Chairman, Mr. H. S. Hurst, and the Director was appointed to go into details.

Salary Scales of Research Assistants.

The Chairman referred to the view expressed by the Experimental Committee and the *maximum* salaries of the Research Assistants were inadequate. It was essential to preserve continuity of service of the staff so far as possible and in view of the initial salaries and propsects now being offered to young and inexperienced assistant superintendents, he thought the Institute would have to increase the *maximum* of this scale. Otherwise they might lose the services of experienced members of the junior staff.

On the proposal of Mr. Amarasuriya, who was seconded by Mr. C. E. Jones, it was unanimously agreed that the Chairman and the Director should go into the question and make proposals.

8. SENIOR SCIENTIFIC STAFF

Reported that the seal of the Board had been affixed to Dr. Tubbs' new agreement on the 6th instant, in the presence of two members of the Board and the Director, as sanctioned by the Board at the meeting held on the 22nd December, 1945.

9. DRAFT REPORT OF THE BOARD FOR 1945

The Draft Report of the Board for 1945 was approved subject to one minor correction.

10. RESOLUTION BY MR. R.C. KANNANGARA IN REGARD TO THE PREPARATION OF A HANDBOOK ON TFA

In consequence of Mr. Kannangara's absence, consideration of this was deferred.

11. ANY OTHER BUSINESS

The Director reported that on the occasion of the recent one day Hartal on the 4th June, St. Coombs labourers had ceased work but there had been no disorder of any kind.

The Meeting then concluded with a vote of thanks to the Chair.

ROLAND V. NORRIS,
Secretary.

CONFERENCE

It is proposed to hold a Conference at St. Coombs about February or March next year to which all interested in the Tea Industry are cordially invited.

Full particulars will be published later.

C. H. GADD
Acting Director.

The Tea Research Institute of Ceylon.

BOARD OF CONTROL

(A) Representing the Planters' Association of Ceylon :—

(1) Mr. R. C. Scott, C.B.E., (on leave), Mr. E. G. Groves (acting).

(2) Mr. H. S. Hurst

(3) Mr. H. de T. Wilkinson-Kay.

(B) Representing the Ceylon Estates Proprietary Association :—

(4) Mr. J. C. Kelly

(5) Mr. D. T. Richards (on leave) Mr. F. A. Bond (acting)

(6) Mr. W. H. Attfield

(C) Representing the Low-Country Products' Association :—

(7) Mr. F. Amarasuriya

(D) Representing the Small-Holders :—

(8) Mr. S. Vytilingam, M.S.C.

(E) Ex-Officio Members :—

(9) The Hon. the Financial Secretary.

(10) The Director of Agriculture.

(11) The Chairman, Planters' Association of Ceylon.
(Mr. R. Singleton-Salmon, Acting Chairman).

(12) The Chairman, Ceylon Estates Proprietary Association.

Acting Secretary, C. H. Gadd, D.Sc., St. Coombs, Talawakelle.

CONTENTS.

The publications of the Tea Research Institute will be sent, free of charge, to Superintendents of Ceylon tea estates, over 10 acres in extent, and to Estate Agencies dealing with Ceylon tea, if they register their names and addresses with *the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.*

Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.